

RockBats
 Technical Note
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Failure Stresses and Failure Modes of Solid-Wood Bats

Why do solid-wood bats fail? If you slowly bend a piece of clear, straight-grained, high-strength hardwood, it will fail at approximately 15,000 psi (on average). If you shape that same clear, straight-grained, high-strength piece of hardwood into a baseball bat, and make contact with a baseball, the dynamic stresses in the handle can reach over 30,000 psi. What this means is that for a fraction of a second (approximately 0.007 seconds), the stresses induced by hitting a baseball are higher than the breaking strength of the wood (depending on the bat and ball speeds).



Finite element analysis of the bat-ball collision has shown that the stresses in the handle can be 4 times higher when you hit 5 inches away from the sweet spot, compared to hitting on the sweet spot. When contact is made just 2 inches from the sweet spot, the stresses in the handle are still 2 to 2.5 times higher.¹

So why don't bats fail every time? It is the shock-absorbing and resilient nature of wood that allows it to spring back and survive many hits. Yet, eventually, even the best solid-wood bats will fail, because not even the best hitters can hit on the sweet spot every time. The sweet spot of solid-wood bats vary from bat to bat due to density and stiffness variation. Knowing the exact sweet spot location of a solid-wood bat is vital to prolonging its service life. If you see ball marks even 2 inches away from the sweet spot, then you have likely subjected your bat to stresses that exceed the breaking strength of wood.

How do solid-wood baseball bats fail? Nearly all bat failures occur in the handle region due to stresses described above. When a ball is hit near the tip of the barrel, the bat is flexed backwards and rupture usually occurs on the front side of the bat handle. When a ball is hit near the handle, the momentum of the barrel is carried forward, and this can result in failure on the backside of the handle (see photo above).

Types of failures. It is important to understand the different types of bat failures. When a bat fails along an oval-shaped failure plane, this is an indication that the angle of grain was not straight along the length of the bat. At RockBats, we grade our wood so that the angle of grain is straighter than 1" of deviation over a 28" length of bat (1:28). This level of straight-grain assures that the piece of wood maintains at least 90% of the strength of a perfectly straight piece of wood. Our Founder was involved in the 2008 MLB Broken Bat study, and MLB adopted a 1:20 slope-of-grain requirement as a result. When you see a bat failure like the one below, this is an indication that the grain was not straight.



When a manufacturer does a good job of grading and sorting out good straight-grained wood, the failures in bats are quite different – as shown in the photos below.



The bat on the left failed by what is called a "rupture" failure, and the bat on the right also failed by rupture – and then followed the straight-grain along the length of the handle.



¹Smith, L. V., Hermanson, J. C., Rangaraj, S. V., Bender, D. A., 1999. "A Dynamic Finite Element Analysis of Wood Baseball Bats," Proceedings of the Summer Bioengineering Conference, pp. 629-630, Big Sky, MT.

It should be understood that even bats with good straight-grained wood will fail under the high stresses. At RockBats, we strive to eliminate slope-of-grain type of failures by implementing a high grading standard.